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Experiment Station Work,

XII.

SEAWEED.
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WHEN TO CUT ALFALFA.
SPONTANEOUS COMBUSTION OF HAY.
PRESERVATION OF MILK BY PRESSURE.
CREAM RAISING BY DILUTION.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

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CONTENTS OF THE SERIES OF FARMERS' BULLETINS ON EXPERIMENT STATION WORK.

EXPERIMENT STATION WORK.

Editor: W. H. BEAL.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK—XII.[1]

SEAWEED.

A valuable agricultural resource of our Northern coast regions is the seaweed or seaware, which collects upon shelving beaches or in inlets (drift weed, of which kelp is the principal component) or which may be cut from the rocks at low tide (cut weed, of which rockweed[2] constitutes the larger part). This material is used to a considerable extent, especially as a fertilizer, on the New England coast, but it is doubtful whether its value is fully appreciated and whether it is utilized to the extent to which it might be economically employed.

A number of the experiment stations have made analyses of seaweed and seaweed ashes, and a few years ago the Rhode Island Station published the results of a very thorough study of the characteristics, composition, and uses of the various more common species of seaweed found on the New England coast. A more recent study of the subject in its bearing upon Scotch agriculture has been made by James Hendrick, of Aberdeen University, Scotland. These studies throw much light upon the question of the value of seaweed and the extent to which it may be profitably used.

They show that a variety of uses have been made of seaweed. Several species are edible, the most important of these being Irish or carrageen moss, used in the preparation of jellies (blanc-mange and similar dishes). Dulse, or dillesk, and kelp, or tangle, are also used to a limited extent as human food. Irish moss and some other species have also been found valuable as cattle foods, especially when boiled (to

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[1] This is the twelfth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

[2] Harvey states that the rockweeds (round and flat stalked) constitute at least three-fourths of the covering of the tidal rocks on the east coast of America.

destroy the rank taste) and mixed with meal. The food constituents in two species of seaweed (partially dried) are shown in the following table:

Food constituents in seaweeds.

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Eelgrass	26.64	6.03	0.19	32.02	9.05	26.07
Flat-stalked rockweed	27.11	8.21	.67	41.14	4.40	18.47

The table shows that these two species of seaweed compare favorably with average hay as regards probably the most important constituent, i. e., protein. They are deficient in fat, but contain a very large amount of ash. The nutritive value of any feeding stuff depends largely upon the digestibility of its constituents. No investigations on the digestibility of seaweed have been made, so far as the writer is aware. It is reasonable to assume, however, that the coarse eelgrass would prove much less digestible and consequently a poorer feeding stuff than the more succulent, mucilaginous rockweed.

Eelgrass has been used in filling mattresses, cushions, etc., and in sheathing houses. Seaweed ashes were formerly utilized to a considerable extent for the manufacture of alkali for use in soap and glass making and for the preparation of iodin and other substances useful in medicine and the arts, and it is stated that substitutes for horns, shell, etc., have been prepared from gelatinous substances of certain seaweeds. As a rule, however, cheaper sources of most of the materials furnished by seaweed have been discovered, and as a consequence the number of uses to which they are put has greatly decreased.

The principal use of seaweed at the present time is as a manure. It is extensively used for this purpose on the coasts of Great Britain, Ireland, France, Germany, Scandinavia, and New England, some of the best farms of the last-named region, according to Storer, being maintained largely by the use of seaweed. Exact data as to the quantity of this material used in the United States are not available. It is reported that in 1885 the value of seaweed used as a fertilizer in Rhode Island alone was about $65,000.

The use of seaweed as a manure is necessarily confined to within a short distance of the seacoast. The material is very bulky and watery (containing from 70 to 90 per cent of water), and consequently can not be profitably transported to a great distance. It has been carried inland, however, to a distance of from 8 to 10 miles. It is undoubtedly an economical practice to allow the seaweed to partially dry on the beach before carting it to the land. It is, however, not advisable to allow the material to dry out so thoroughly that it will not readily decompose in the soil or to subject it to any considerable amount of fermentation or leaching, as in this case a large proportion of its valuable constituents—nitrogen and potash—will be lost. On account

of its bulk and watery condition it is necessary to apply seaweed in very large amounts, 20 to 30 tons per acre, in order to supply sufficient amounts of nitrogen, phosphoric acid, and potash for the needs of crops.

The fertilizing constituents in various kinds of seaweed, as compiled from analyses made at the Rhode Island Station and elsewhere, calculated to a uniform basis of 80 per cent of water, are shown in the following table:

Fertilizing constituents in different kinds of seaweed.

[Calculated to a uniform basis of 80 per cent of water.]

	Nitrogen.	Phosphoric acid.	Potash.	Lime.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ribbon weed, kelp, or tangle (*Laminaria saccharina*)	0.327	0.116	0.488	0.789
Broad ribbon weed, broad-leafed kelp, devil's apron, or tangle (*Laminaria digitata*)	.347	.092	.498	.470
Drift weed, mostly kelp (*Laminaria* spp.)	.444	.131	1.217	.524
Round-stalked rockweed (*Ascophyllum* (*Fucus*) *nodosum*)	.373	.072	.706	.355
Flat-stalked rockweed (*Fucus vesiculosus*)	.347	.084	.542	.444
Fucus furcatus	.256	.059	1.109	....
Eelgrass, or grass wrack (*Zostera marina*)	.328	.128	.368	.597
Irish, or carrageen moss (*Chondrus crispus*)	.564	.105	.850	.366
Dulse, or dillesk (*Rhodymenia palmata*)	.614	.104	1.620	.115
Cladostephus verticillatus	.314	.156	.984	.604
Polyides rotundus	.660	.120	.288	.489
Phyllophora membranifolia	.642	.085	.580	2.927
Ahnfeldtia plicata	.338	.078	.700	.176
Average	.409	.097	.701	.597

The above table shows that average seaweed in the moist state contains about 0.4 per cent of nitrogen, 0.7 per cent of potash, and less than 0.1 per cent of phosphoric acid. If we allow 10 cents a pound for the nitrogen, 2 cents for the phosphoric acid, and 4 cents for the potash (and these were the lowest prices at which these constituents could be bought in 1898 in any materials from which commercial fertilizers are made), a ton of seaweed (with 80 per cent of water) is worth $1.42 as a fertilizer.

The potash of seaweed, which is probably its most important fertilizing constituent, is subject to wide variation. Fresh seaweed often contains 1 per cent and more of this constituent, but it is soluble and is rapidly lost if the weed is subjected to washing. The lime is also very variable, owing to the adherence of shells, etc., but normally it is probably less than 1 per cent.

Seaweed belongs to the same class of manures as barnyard manure and green manures. At the same time that it furnishes more or less of all the constituents required by plants, it supplies the soil with a large amount of humus to improve its physical properties. For this reason it proves especially valuable on porous, sandy soils. It differs from average barnyard manure in its higher percentage of potash and lower percentage of phosphoric acid. While, like barnyard manure, it is a general fertilizer, it is not so well balanced, and its continued use without the addition of other fertilizers is likely to result in a one-sided

exhaustion of the soil. In order to prevent a deficiency of phosphoric acid as compared with the other fertilizing constituents and an undue draft on this element in the soil, it is necessary to apply seaweed in very large amounts, thus furnishing nitrogen and potash far in excess of the needs of the crop and subjecting them to danger of loss. To get the best results seaweed should undoubtedly be used in connection with bone or other phosphate.

Since seaweed contains a considerable amount of potash which is largely soluble in water, it is correctly considered a potassic manure and especially valuable for soils deficient in potash and crops like potatoes, clover, etc., which are "potash feeders." According to Storer, "there is perhaps hardly another locality in New England where red clover may be seen growing as freely and abundantly as upon the tract of country back of Rye Beach, New Hampshire, * * * which has been manured with seaweeds ever since the country was first settled. Clover grows there naturally and spontaneously, in the sense that it perpetuates itself and remains in the land year after year, much as June grass does in other localities."

The nitrogen of seaweed is in organic form, and is therefore not available to plants until decomposition and nitrification have taken place. With the majority of seaweeds, however, this rapidly occurs in the soil, and it is not considered necessary, as a rule, to ferment the weed before applying it to the soil. It may be applied fresh as a top-dressing (on grass) or may be plowed in. On account of its rapid decomposition seaweed furnishes a valuable means of starting fermentation in manure, compost heaps, peat, etc. These statements apply especially to the more succulent and mucilaginous kinds of seaweed. They do not apply to eelgrass, as a rule. While this kind of seaweed is about as rich in fertilizing constituents as the other kinds analyzed, its actual fertilizing value is much lower because it decomposes very slowly in the soil. In fact, it has been condemned as worthless as a manure for this reason, although useful as a mulch. Its value as a fertilizer could no doubt be greatly increased by composting with manure or lime. The burning of the material and the use of the ashes as a fertilizer has been suggested, but the objection to this practice is the difficulty and expense of burning and the loss of the nitrogen.

Seaweed has been extensively used as a fertilizer for potatoes. It is claimed, however, that the quality of the tubers is impaired if the weed is applied in the spring or at time of planting. This is probably due to the chlorin which the seaweed contains in considerable amounts, it being a well-known fact that chlorin in large amounts in the soil has a tendency to lower the starch content of potatoes, and thus injure their quality. This objection may be met in large part by applying the weed the preceding summer or fall, as is quite generally done by New England farmers. In any case the seaweed should be given sufficient time to decay in the soil before planting the potatoes. In experiments made by James Hendrick, in Scotland, seaweed was compared

with barnyard manure and commercial fertilizers applied in the spring to early potatoes. Seaweed alone and barnyard manure alone were about equally effective in increasing the yield. Seaweed combined with superphosphate gave a larger yield than manure alone or manure and superphosphate. The potatoes grown with manure, however, were of better quality than those grown with seaweed. The potatoes grown with seaweed were apparently more immature and deficient in starch than those grown with the manure. It is suggested that the seaweed prolonged the period of growth and would have given better results with late potatoes.

It has been observed at the Rhode Island Station and by farmers in that State that seaweed applied at the time of planting tends to decrease scab in potatoes. In this respect it possesses a decided advantage over barnyard manure, which is known to favor the development of scab. Another advantage which seaweed possesses is its freedom from weed seeds, eggs of insects, and germs or spores of plant diseases. Where both stable manure and seaweed are available, it is considered good practice to use the former on grass and the latter on plowed land.

SUMMARY.

While seaweed has been used for a variety of purposes, it is chiefly valuable as a manure. For this purpose it may be classed with green manures and barnyard manure, though differing from the latter in its higher content of potash (largely soluble) and lower content of phosphoric acid. On account of its high content of potash, seaweed is best adapted to soils deficient in this element and to crops which are "potash feeders," such as potatoes, clover, etc. To secure a well-balanced fertilizer adapted to general purposes the seaweed should be combined with a phosphate of some kind.

While the different species of seaweed are very similar in chemical composition, they are not all of the same fertilizing value. Eelgrass, on account of the slowness with which it decomposes, is probably the least valuable species as a manure, although useful as a mulch. When rotted in composts its fertilizing value is greatly increased. The seaweeds of most importance as fertilizers are kelp and rockweed. These rapidly decompose in the soil, readily yielding up their fertilizing constituents to crops. It is therefore most economical to apply them to the soil as a top-dressing or to plow them in in the fresh condition without previous fermentation. Seaweed gives best results on warm, sandy soils, which it stocks with humus.

Seaweed, when applied in the spring, has been found to injure the quality of potatoes, probably on account of the chlorin which it contains. It also apparently delays maturity as compared with barnyard manure. It seems, however, to reduce scab when applied at planting. Undoubtedly the safest practice with potatoes and other plants injured by chlorin is to apply the seaweed the previous summer or fall.

An advantage of seaweed over barnyard manure is its freedom from weed seeds, insects, and germs or spores of plant diseases.

Since the bulky character of seaweeds makes it unprofitable to transport them very far inland, it has been suggested that they be burnt and the ashes used, but the difficulty and expense of this practice renders it of doubtful economy.—THE EDITOR.

THE TILLERING OF GRAINS.

Grains tiller or stool when they throw up shoots from the root after the seed has sprouted and the main stem has made its appearance. A stool of grain thus consists of the stems and shoots produced from a seed, and may be considered a single plant. This method of growth is characteristic of the grasses to which all cereal crops belong. The number of shoots which grow and develop into grain-bearing stems depends mainly upon the fertility of the soil, the influence of weather conditions, and the distance between plants. Worn-out soils, or soils in which the plant food is not readily available; cold weather, either too wet or too dry, and sowing the grain too thickly, are conditions which are detrimental to tillering. In considering the subject, it is taken for granted that the seed is of good quality.

The fertility of the soil and the spacing of the plants are factors which are under the control of the farmer, but the weather conditions vary with locality and season. In dry regions, where the important factor of soil moisture is unreliable, the tendency is not to rely very extensively upon the tillering process, but to sow greater quantities of seed per acre in order to obtain the required stand.

Comparatively little work has been done in this country on the tillering of grain, but extensive investigations of the amount of wheat, oats, and barley to be sown per acre have been made, and the effect of tillering may be inferred to some extent from the data obtained. However, direct investigations on the subject are few as compared with work on other phases of the culture of cereals. The Wyoming Station has recently published the result of investigations on the tillering of wheat, oats, and barley grown at five different places in the State, namely, Laramie, Lander, Wheatland, Sundance, and Sheridan. The results of this work are of interest not only in so far as they concern the tillering of cereals, but also inasmuch as they throw light on the growing of grains at high altitudes and in arid climates. The altitude of the different places where these experiments were made varied from 4,000 to 7,200 feet. In one case only were the plants grown without irrigation. The tillering experiments were conducted with a comparatively small number of plants, but in order to show what the results might be in actual field practice, a series of plat experiments with different amounts of seed per acre was made for the purpose of comparison.

In general, the results indicate that the number of mature heads produced by each seed varies greatly with the locality and the season,

and that the number of heads and the amount of grain produced increase rapidly with the space given each seed. It was found that plants grown at wide distances apart produced shorter straw and a greater proportion of straw to grain than when thickly planted. The greater proportion of straw is considered to be due to the increase in the number of adventitious stems and the number and size of the leaves as each plant is accorded greater space within certain limits. It was noticed that, where too much room was given, many more stems were produced than would mature heads; and that, on account of the continuous growth from the crown of the stool during the summer, the grain matured late, did not fill well, and consequently was light in weight and of inferior quality. Larger heads were produced upon grain planted more than 1 inch apart, although they did not seem as uniform in size as the heads of plants grown at the smaller distance. The number of seeds in the largest heads produced was found to increase rapidly with the distance between plants. It is stated that more grain will be produced by each seed when planted at greater distances than 1 inch apart, but that the actual amount of grain will be less for the area of land used. "A study of our experiment seems to indicate that in farm practice sowing seeds so plants will be secured about 1 inch apart in the drill will produce the largest yields per acre of wheat or barley, but that oats should probably be planted a little thicker than this."

The author concludes from his investigations that, if 80 per cent of the seed germinates and it is sown in drills 8 inches apart, it requires 78 pounds of wheat weighing 61 pounds per bushel, 86 pounds of barley weighing 53 pounds per bushel, and 61 pounds of oats weighing 40 pounds per bushel to seed an acre with plants 1 inch apart in the row.

At Laramie in 1897, 50 and 70 pounds of wheat per acre gave as large yields as greater amounts of seed, but where 100 pounds per acre were sown the grain weighed more per bushel and ripened earlier. There was little difference in the yield of barley plats sown at different rates per acre, but the plats with the heavier seeding ripened earlier and produced better grain. Oats seeded at the rate of 60 pounds per acre gave the best yield; thinly seeded plats failed to ripen the grain fully. At Sheridan in 1897 the best yields were obtained from sowing 50 to 70 pounds of wheat, 70 to 80 pounds of barley, and 80 to 100 pounds of oats per acre. The results obtained at the five different places indicate that barley has the greatest tillering power, followed by wheat and oats in the order mentioned, and that barley stands first in the yield of grain, oats second, and wheat third.

The results further showed that thick seeding of grain at high altitudes is an important factor in shortening the time required to mature the crop, and that upon like soils and under otherwise similar climatic conditions wheat, oats, and barley naturally produce less mature heads and less grain the higher the altitude at which they are grown.

The effects of irrigation were marked and beneficial. Grain under irrigation produced more mature heads per stool and gave a better yield of grain than that grown without irrigation.

"The amount of grain produced from different amounts of seed per acre varies in different seasons. On account of increased tillering light seeding (from 30 to 50 pounds per acre) may produce as much grain as would a larger amount of seed, but when more seed is sown the difference in weight of grain per bushel along with a shorter period of maturity and evenness in ripening may more than pay for the extra seed used."—J. I. SCHULTE.

FERTILIZERS FOR GARDEN CROPS.

Since 1892 the Massachusetts Hatch Station has been conducting a series of experiments to test the relative value of nitrate of soda, sulphate of ammonia, and dried blood, as sources of nitrogen for different garden crops; and, at the same time, to make a comparison of muriate with sulphate of potash, when used with each of the three nitrogenous fertilizers for the same class of crops. Dissolved boneblack was applied equally to all plats from the first. These experiments were continued unvaried until 1897. Sulphate of potash in connection with nitrate of soda generally gave the best crop; in cases where it did not, it gave one but slightly inferior to the best except in the case of one crop, sweet corn, a plant which makes much of its growth in the latter part of the season. Nitrate of soda in almost every instance proved the most valuable source of nitrogen, whether used with muriate or sulphate of potash. Sulphate of ammonia and muriate of potash when used together gave the poorest yield in every instance. This result was apparently due to a chemical reaction between these two substances in the soil resulting in the formation of ammonium chlorid, a substance which is injurious to plant growth.

Up to 1897, as has been already stated, only chemical fertilizers were used, but in 1898 a change was made in the plan of the experiment. In view of the fact that market gardeners, in whose interest chiefly these experiments were carried out, almost invariably use large quantities of stable manure, and employ commercial fertilizers, if at all, simply to supplement the manure, it was decided to apply equal amounts of thoroughly mixed stable manure to each plat and to use in addition the same fertilizers as before. Further, in order to have the best data for determining whether the fertilizers should prove in any degree useful, another plat was added to which manure alone was applied. A number of different garden crops were grown, including spinach, lettuce, table beets, tomatoes, and cabbage; and, as a second crop, turnips.

Spinach gave by far the best results with nitrate of soda. On sulphate of ammonia plats it was almost an absolute failure, many plants dying soon after germination and most of the others becoming yellow and sickly. Sulphate of potash gave somewhat better returns than did the

muriate. Very similar results were obtained with beets. Most of the plants on the sulphate of ammonia plats became weak and sickly and many died; but the few that survived until about July gradually recovered their vigor and grew very rapidly. The results with tomatoes were also in part similar. Sulphate of potash gave somewhat better returns than the muriate, and nitrate of soda gave the best yield of any of the sources of nitrogen; but the differences were far less pronounced than in the cases of spinach and beets. Contrary to the results in these cases, however, the sulphate of ammonia did not appear to have injuriously affected the crop. This is thought to be due to the fact that the tomato is not set until about the first of June, and makes most of its growth when the season is well advanced. By this time the injurious compounds formed by the sulphate of ammonia have been washed away by rain or destroyed by further chemical changes. The crops that were injured by the sulphate of ammonia, spinach and beets, are sown early and make most of their growth before the season is far advanced.

Lettuce yielded better on barnyard manure alone than on the plats to which fertilizers were also applied. This result is exactly in line with the results obtained at the New York State Station, an account of which appeared in an earlier bulletin of this series,[1] where it was found that "after the soil has received a heavy application of stable manure, any further addition of chemical fertilizers is only thrown away." Here, as before, sulphate of ammonia was found to be highly injurious, especially when used with muriate of potash.

Cabbage appeared to be somewhat benefited by the addition of fertilizers to barnyard manure. The difference in the effect of the different fertilizers was not very marked. Nitrate of soda appeared to be the best source of nitrogen.

The plats from which the beets, lettuce, and spinach had been harvested were plowed and sowed to turnips without further fertilizing. In this case the crop was decidedly better on the plats which had received fertilizers in addition to manure. Not much difference was observed in the effect of the two potash salts, and the plats which had received sulphate of ammonia gave a much better crop than those which had received the other nitrogenous fertilizers. This result, apparently so much at variance with those reported above, is thus accounted for: "(1) The plats to which the sulphate of ammonia had been applied had produced but very small crops [of beets, lettuce, and spinach] while the others had yielded heavily; and (2) the turnips made their growth so late in the season that the injurious compounds often formed by this salt had become dissipated or destroyed by further chemical changes."—V. A. CLARK.

SWEET CORN AND POLE BEANS UNDER GLASS.

"The near future will no doubt see many new departures in the forcing of vegetables," remarked Professor Bailey less than three years

[1] U. S. Dept. Agr., Farmers' Bul. 92 (Experiment Station Work—IX).

ago. Since that time a number of experiments have been undertaken with a view to extending the list of vegetables practically available for forcing on a commercial scale. Notably among these are the experiments made by the New Hampshire Station with green corn and pole beans. It may seem somewhat remarkable that these common vegetables had not been forced before, when such comparatively little known ones as pepino and cyphomandra had been, but perhaps the reason is that the corn and pole beans require considerably more space above the bench or bed in which to develop than most other crops.

For this reason the nature of the forcing house is important. The modern lettuce and cucumber house, with beds directly on the ground, is well adapted to these crops (see figs. 1 and 3). The greenhouse requisites are practically the same as for forcing tomatoes, eggplants,

Fig. 1.—A crop of corn with ears formed; greenhouse, New Hampshire Station.

melons, and cucumbers. The temperature should not be allowed to fall below 60° F. at night; 70° would be better. During the day it should be ten or more degrees higher. The house should be kept moist except during the period of pollination of the corn, and the soil should never become very dry.

Either crop thrives in any good greenhouse soil. Much time may be saved by soaking the seed and starting the plants in flowerpots. Care should be taken, however, that the plants do not become root-bound, as the setback thus given materially lessens all chances for a full crop. In the case of beans, the time thus saved is from two weeks to a month.

The most economical distance for setting plants is, for corn, 9 inches in the row, with rows 18 inches apart. With beans, hills 18 inches apart each way, and two or three plants in each hill, give excellent results. When planted so thick the foliage is very dense, but this does not

appear to diminish productiveness. The only training the corn requires is removal of suckers. It is well, however, to cut off about half of the tassels, thus throwing more strength into the ears.

Beans, of course, must have a support. This is best supplied by a string trellis (fig. 3). Wires are run parallel with each row and directly over it at the proper height, a wooden peg, with a notch cut near the top, is driven into each hill, and the two are connected by a string.

FIG. 2.—Varieties of corn grown under glass: 1, Early Minnesota; 2, Crosby Early; 3, White Cob; 4, First of All; 5, Early Fordhook; 6, Adams Extra Early.

Poles may also be used, but they make more shade and do not admit of so great utilization of the overhead space.

In respect to pollination, corn and beans differ very favorably from many forcing-house crops, as tomatoes and cucumbers, which usually require considerable hand labor in order to set the fruit. In the case of corn it is necessary that the atmosphere be not too moist when the pollen is ripe, but otherwise no attention is, as a rule, required. In the case of beans, even this precaution is not necessary, as the flowers are self-fertile. As an extra precaution in the case of corn, it may be

well to go over the house, cutting a tassel here and there and dusting the silk with it, but it is doubtful if even this is necessary.

During the early stages of growth a catch crop, such as radishes or Grand Rapids lettuce, can be taken off, or the unused space can be utilized for starting plants that are to be transplanted.

The time required to mature a crop of the extra-early varieties of sweet corn in the experiments was 83 days. The standard early varieties, as Crosby, required 86 days; but probably, with more favorable conditions and more experience, the time could be considerably reduced. In the case of early beans the time required was from 54 to 62 days for a number of sorts. Dwarf varieties grown for comparison required 55 days.

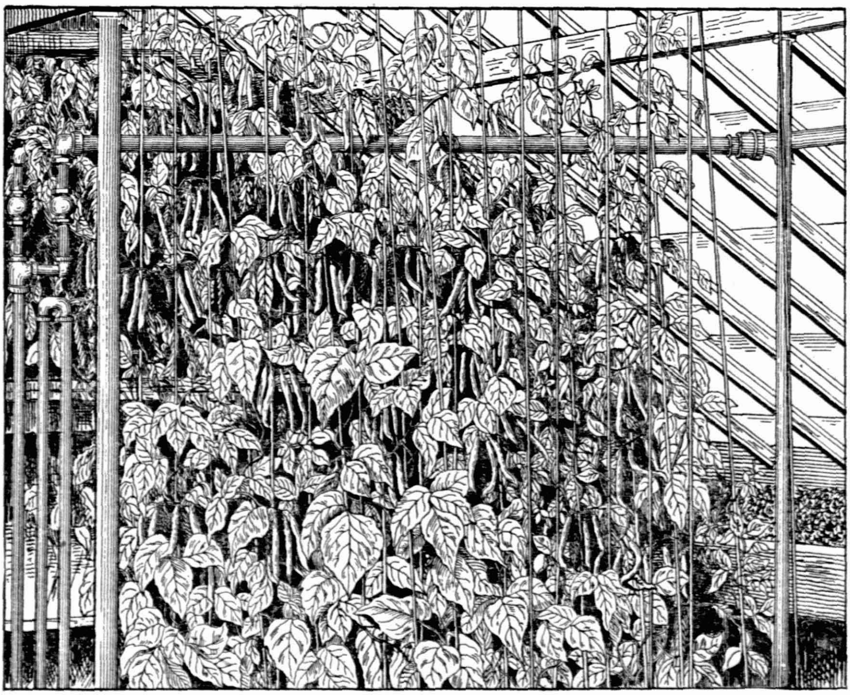

FIG. 3.—Pole beans running upon string trellis; greenhouse New Hampshire Station.

The average yield of dwarf varieties per hundred plants was 280 ounces, while the average yield of the pole beans was 1,136 ounces. Again, 73 per cent of the bush crop was gathered at the first three pickings, while the crop of pole beans was well distributed over eight. It is thus seen that the pole bean is much more productive than the bush bean. In the experimental plantings, practically no trouble with insects and fungus diseases attended the growing of the crops. Rats and mice, however, committed some depredations. They should be poisoned before planting the crop.

A number of varieties of both vegetables were tested. Varieties of sweet corn that did very well were Crosby Early, First of All, and White Cob (see fig. 2). The last was earliest, but the first was considered on the whole more desirable. Varieties grown successfully in the garden seemed to do equally well under glass. Varieties of pole beans that did well were Mastiff Golden Pod, Early Golden Cluster, and Golden Champion, named in the order of productiveness.

These crops can be grown under glass much more easily and with less risk than some other crops. The danger, so far as observed, from insect and fungus enemies is small and the crop matures satisfactorily. But the crucial question of the commercial grower still remains unanswered: Does it pay? As a result of its investigation, the New Hampshire Station believes that this question may be answered in the affirmative. In the East forced bush beans are generally sold by the bunch of 25 to 50 pods. The price varies according to demand; probably 25 to 50 cents per bunch may be considered an average. "If dwarf beans have been made a success, surely the best pole varieties, being more productive, can not help becoming a profitable crop under similar conditions."

In the case of green corn it is not so easy to estimate the returns, since this vegetable does not appear in the Northern market before July and hence has no fixed price. Nevertheless, the New Hampshire Station believes the industry will be profitable. "Without any sweet corn on the market before July, we have a rather long period even in spring when this vegetable has no competition. While it has no established market price at present in our cities, it naturally follows that, like other forced greenhouse crops, the returns should at least be in proportion to its cost, and doubtless until commonly grown would be much more profitable. Sweet corn when first in season is doubtless as highly prized as any other of the green vegetables; and taking this fact into consideration, we believe that when offered out of season it will be in great demand."—V. A. CLARK.

GIRDLING OR RINGING GRAPEVINES.

"The operation of girdling, or more properly speaking, ringing, grapevines consists in removing a ring of bark from the bearing arm about an inch wide or wide enough so that the bark will not heal over the wood that has been laid bare." The same result is sometimes accomplished by compressing the branch with wire.[1] The operation has been practiced more or less for many years for the purpose of hastening maturity and improving the size of the grapes. The explanation of this effect on the fruit is given in a bulletin of the New York State Station as follows:

The food materials taken in by the roots pass up through the outer layers of wood to the green parts of the plant. Here new material for growth is formed and the

[1] About No. 20 wire is recommended by the Massachusetts Hatch Station.

portion that is not needed by the leaves and other green parts passes downward, for the most part through the inner bark, to be distributed wherever it is needed. The wood is not disturbed in the process of ringing, therefore the upward movement of the solutions is not interfered with; but since the downward passage takes place through the inner bark the flow is arrested when it arrives at the point where the bark has been removed. Consequently the parts of the plant that are above the point where the ring of bark has been removed receive more than a normal supply of food, which tends to produce increase in size and earlier ripening of the fruit.

As early as 1877, the effects of girdling were tested in the vineyard of the Massachusetts Agricultural College, and a study of the subject has since been continued at that institution with very favorable results. In these tests the ripening of the fruit was hastened sometimes as much as ten days or two weeks and the size also increased without loss of palatability if picked in good season. In wet seasons the berries tended to crack open and to be too soft for marketing. In some cases the fruit on the ungirdled branches seemed to be reduced in quality, and girdling, if freely and continuously practiced, apparently sapped the general vitality of the vine. To avoid injury it was advised to treat only those canes which are to be cut away at the fall pruning and to leave one-half of the canes untreated. As a further precaution it was suggested that girdling be practiced only every alternate year.

The New York State Station made careful tests of the practice on a number of varieties in two localities in New York in 1896 and 1897. It was found, as a rule, that ringing produced earlier ripening and larger bunches and berries.

The first season the effect on the fruit of some varieties was very marked. Fruit on ringed vines of Empire State was not only larger in both bunch and berry, but began ripening twenty-one days before fruit on unringed vines. Other varieties did not show any gain in size or earlier maturing of the fruit when ringed.

The fruit of some varieties, as the Delaware, showed a lack of quality when ringed, while thin-skinned varieties, as the Worden, showed a greater tendency to crack when grown on ringed vines.

The second season the effect of ringing was not nearly so marked, thus showing that the season has something to do with results obtained. * * *

Cutting back the new growth on ringed arms appeared to result in giving better quality to the fruit. * * *

That the effect of ringing is devitalizing to the plant there can be little doubt, but when judiciously managed the cumulative effect on strong-growing varieties need not result disastrously. * * *

Vines grown on the renewal system would seem to be better adapted to ringing than those grown on the Kniffin plan, since with the former more wood can be left to support the vine than is possible with the latter system. * * *

Where the vines are grown on the two-arm Kniffin system the ring of bark is commonly taken from both arms just beyond the fifth bud. It has been found that the ten buds that are left to the vine produce enough leaf surface to supply the food necessary to keep the vine in a vigorous condition, providing the vineyard has received proper care. Where the four-arm Kniffin system is used some growers ring the two top arms only, leaving three or four buds on each for renewal. The two lower arms, it is claimed, will bear as good fruit as adjacent vines that have not been ringed. With the renewal system the two main arms are usually ringed just beyond the renewal bud. With this system of training several shoots are left in the center of the plant which supply a sufficient amount of plant food to support the vine.

Some growers find it more satisfactory to ring their vines every other year, since with this method the vines are given an opportunity to recover from any loss of vigor they may have suffered.

With any system of training, in order to get the best results, the vines must not be allowed to carry too large a crop of fruit. Since each ringed arm acts independently so far as maturing its fruit is concerned, it will be seen that there is a certain relation between the leaf surface and the amount of fruit on the ringed vine. A large amount of fruit with insufficient leaf surface on the ringed arms results in inferior or even worthless grapes; hence the importance of an abundance of foliage free from plant disease and insect attack. It is equally important that there be an abundance of healthy foliage back of the rings in order to supply the plant with sufficient nourishment to keep it in a vigorous condition. All fruit back of the rings should be removed, for if allowed to remain it does not properly mature, and only adds a useless drain on the plant's vitality. * * *

Growers have found that the best results with ringing are obtained by doing the work when the grapes are about one-third grown, the exact time depending on the season and variety. The operation may be performed with a knife, but, where ringing is extensively engaged in, a tool designed for the purpose is used.

Forms of a tool used for girdling by the New York State Station and the appearance of girdled canes are shown in fig. 4.—THE EDITOR.

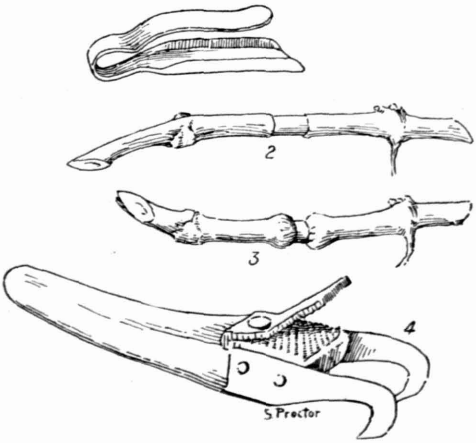

FIG. 4.—Tools used by the New York State Station in girdling grapevines, and appearance of girdled vines.

CEREAL BREAKFAST FOODS.

A very large number of cereal breakfast foods are on the market at the present time. The majority are made from wheat or oats, although some are prepared from corn, rice, and barley. Many of these preparations are similar in appearance, although they vary greatly in price. Some are sold in bulk and others are placed on the market in more or less attractive packages. The claims made by the manufacturers as to the value of special brands are often very extravagant and in some cases are manifestly prepared by those who are unfamiliar with the chemistry of nutrition. The trade names of the preparations from the different cereals vary greatly, but the products from the same cereal are found to be more or less similar, and may be divided into a

few groups on the basis of the mechanical process employed in preparing them. In nearly every case more or less of the outer covering of the grain is removed and the remainder ground, rolled, or crushed. A large number of the preparations are partially cooked, usually by steam; some few are parched.

The composition of cereal breakfast foods has been recently studied by the Wyoming and New Jersey stations and by the Division of Chemistry of this Department. In the table below the average composition of the principal classes of cereal breakfast foods is shown, the average composition of wheat flour of different grades being included for purposes of comparison. Only average figures are given, since the different brands were not found to differ more markedly in composition than different specimens of the same brand.

Composition of cereal breakfast foods and wheat flour.

	Water.	Protein.	Fat.	Carbohydrates (including crude fiber).	Crude fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn:						
Flaked (average of 5 analyses)	10.3	9.6	1.1	78.3	(0.4)	0.7
Hominy (average of 17 analyses)	11.8	8.3	.6	79.0	(.9)	.3
Parched (average of 2 analyses)	5.2	11.5	8.4	72.3	....	2.6
Oats:						
Oat meal (average of 16 analyses)	7.3	16.1	7.2	67.5	(.9)	1.9
Rolled oats (average of 20 analyses)	7.7	16.7	7.3	66.2	(1.3)	2.1
Miscellaneous preparations with different trade names (average of 26 analyses)	7.9	16.3	7.3	66.8	(.9)	1.7
Rice: Flaked (average of 2 analyses)	9.5	7.9	.4	81.9	(.2)	.3
Wheat:						
Cracked and crushed (average of 11 analyses)	10.1	11.1	1.7	75.5	(1.7)	1.6
Flaked (average of 7 analyses)	8.7	13.4	1.4	74.3	(1.8)	2.2
Germ preparations (average of 10 analyses)	10.4	10.5	2.0	76.0	(.9)	1.1
Gluten preparations (average of 3 analyses)	8.9	13.6	1.7	74.6	(1.3)	1.2
Parched and toasted (average of 6 analyses)	8.6	13.6	2.4	74.5	(.8)	.9
Shredded (average of 6 analyses)	8.1	10.5	1.4	77.9	(1.7)	2.1
Patent flour, high grade, spring wheat	12.3	11.7	1.1	74.5	(.1)	.4
Patent flour, high grade, winter wheat	13.3	11.0	.9	74.4	(.3)	.4
Flour, low grade	12.0	14.0	1.9	71.2	(.8)	.9

It will be seen that the different preparations from the same cereal do not vary greatly in composition. The Wyoming Station discusses the cereal foods as follows:

The chemical analyses and examination of the starch grains with the microscope showed no evidence of the presence of foreign cereals, so adulteration may be regarded as absent in foods of this class. * * *

There is more variation in price than in composition, and there is no discoverable relation between quality and price. Some articles are four or five times the cost of others of the same class and apparently of the same merit. The oatmeal sold in bulk is practically the same in composition and, so far as can be judged by personal taste, in quality and flavor as that sold in packages for several times the price. Of course, in buying bulk articles one is not so sure of getting the same grade or that

the quality has not been injured by long keeping and exposure. * * * The chief advantages of package goods is that the manufacturer is made directly responsible to the consumer. * * *

The claims made for quick cooking are generally fallacious. Almost all such preparations should be cooked for at least half an hour and usually longer to insure the complete digestibility of the starch.

Similar deductions were drawn from the New Jersey investigations. These showed that in all the different classes the price for practically the same kind of preparation was found to vary within wide limits. In some cases the high price was perhaps due to some special method of preparation. The claims made for many of these foods were not found to be justified by their composition.

These claims, extravagant in some instances, should have but little weight with consumers, as the actual amount of nutriment furnished (by similar products) does not greatly differ.

All of the oat products, as well as a number of the wheat, contain considerable amounts of crude fiber—this constituent having been determined in nearly every case in order to show how fully the claims made in reference to the removal of the hull or covering, or woody matter, were verified. In one case it was claimed that the fiber had been entirely removed; this is not verified by the analysis. * * *

[A study of similar products put on the market by different makers shows that] the variations in their composition are not marked, and that such as do occur are probably due to the variations in the composition of the original wheat. In the oat products the protein is the constituent that shows the widest variation, while in the corn and rice products the chief variable constituent is water. * * *

From all the investigations which have been made a number of general deductions seem warranted. As shown by their composition, these cereal products have a high food value. In addition, they are palatable, wholesome, and are believed to have a useful place in diet. In one form or another they agree well with most persons and their use will doubtless become even more extended than at present. In the opinion of hygienists and dietary specialists they are particularly desirable foods for children. Too much sugar should not be eaten with cereals, since they contain an abundance of carbohydrates and heavy sweetening covers the flavor of the grain.

The claim is often made that some especial brand of breakfast food is especially rich in tissue-forming material, i. e., protein. As shown by the table the percentage of this constituent in different preparations from the same grain does not vary markedly. The claim is also often made that these preparations are much superior to flour. It will be seen that in general the differences in composition between flour and the different wheat preparations are not very great. In connection with the dietary studies conducted under the auspices of this Department it has been found that, with the exception of certain meats and dried beans, no common article of diet furnishes protein as cheaply as wheat flour. At present prices the cereal foods are also an economical source of this valuable nutrient.

An attractive form of marketing always tends to attract the purchaser. But those who must economize should know that the goods sold in bulk are as nutritious as the same article sold in a package at a higher price.

Much stress is sometimes laid by the manufacturers on the high content of phosphates or "phosphorus" in the cereal foods. As shown by the figures obtained at the Wyoming Station this factor varies very little with different preparations from the same grain. Physiologists differ as to the amount of phosphorus and other mineral matters required by the body and the form in which such material is most desirable. The opinion of those best informed seems to be that the ordinary diet furnishes enough phosphates and other mineral matters and that under ordinary circumstances no especial effort need to be made to secure such materials.

In view of the high food value of cereal products and their palatability, there seems little need of the extravagant statements which are often made concerning them and which have little if any basis.—C. F. LANGWORTHY.

FOOD VALUE OF APRICOTS, CHERRIES, PEACHES, PLUMS, AND PRUNES.

In recent years the growing of fruits has assumed great commercial importance in many regions of the United States, especially in the South and on the Pacific coast. The amount of fruit consumed in the average household has undoubtedly increased with the greater production and facilities for shipping and marketing.

The increased consumption of fruit has apparently aroused a somewhat general interest in its food value and many popular articles on the subject have appeared. Some of these contain statements which a study of the chemical composition of fruits would hardly warrant.

Many of the stations have reported analyses of fruits and made extended studies of the different methods of growing fruit trees, their soil requirements, enemies, etc.

The stone fruits constitute an important group, and have been studied for a number of years by the California and Oregon stations. Fresh peaches, apricots, cherries, prunes, and plums are general favorites, while enormous quantities of these fruits are canned, dried, or preserved in some way. It is interesting to compare the composition of these fruits, fresh and dried, with each other and with some of the staple articles of diet.

Composition of edible portion of stone fruits and other food materials.

	Water.	Protein.	Fat.	Nitrogen-free extract (including crude fiber).	Crude fiber.	Ash.	Acid.
Fresh fruits:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Apricots (California)	85.0	1.1		13.4		0.5	....
Cherries (California)	79.4	1.2		19.0		.4	....
Cherries (Oregon)	81.3	.9		[1]17.3		.5	0.4
Peaches	89.3	.9	0.1	9.3		.4	....
Plums (California)	78.4	1.0		[2]20.1		.5	.4
Prunes (California)	80.2	.8		[3]18.5		.5	....
Prunes (Oregon)	76.4	1.3		[4]21.0		.9	.4
Dried fruits:							
Apricots	29.4	4.7	1.0	62.5		2.4	....
Peaches	25.0	2.8	....	70.0	....	2.2	....
Prunes	22.3	2.1		73.3		2.3	....
White bread	35.6	9.3	1.2	52.7	....	1.2	....
Potatoes	78.3	2.2	.1	18.4	(0.4)	1.0	....
String beans	89.2	2.3	.3	7.4	(1.9)	.8	....
Dried beans	12.6	22.5	1.8	59.6	(4.4)	3.5	....
Lettuce	94.7	1.2	.3	2.9	(0.7)	.9	....

[1] Including 11.21 per cent sugar.
[2] Including 13.25 per cent sugar.
[3] Including 16.11 per cent suga.
[4] Including 14 per cent sugar.

Apricot pits constitute about 6 per cent of the fresh fruit, cherry pits 5 per cent, and peach pits 14 per cent.

In general, all the stone fruits included in the table, when fresh, have a high water content. The different kinds do not differ very greatly in composition and the variations between the specimens grown in different regions are not greater than between different samples grown in the same region. The dried fruits contain less water and therefore have a higher food value than the fresh fruits. The fresh fruits contain a much smaller percentage of nutritive ingredients than white bread or dried beans. Judged by their composition they do not differ very greatly from potatoes and are somewhat superior to the fresh vegetables included in the table. It should be remembered, however, that the nitrogen-free extract or carbohydrates of potatoes consists almost entirely of starch. The carbohydrates of fruits consist largely of sugar and bodies whose food value is not well understood. It has been found in the dietary studies conducted under the auspices of the Department of Agriculture that a large consumption of fruits or fresh vegetables containing little food material and a high percentage of water increases the cost of a diet out of proportion to the nutritive material furnished.

As an illustration of this statement, the case of a skilled mill workman's family in New Jersey may be cited. The number of meals taken by the different members of this family during a dietary study was equivalent to 1 man 127 days, or practically 4 months. During this time $2.16 was expended for oranges and $3 for celery, making a total of $5.16 for these two articles, which between them furnished

150 grams of protein and 6,445 calories of energy. During the same time $5.16 was also expended for cereal foods and sugars, and 3,375 grams of protein and 184,185 calories of energy were obtained, or about twenty-five times the amount furnished by the oranges and celery. The amount expended for vegetables and fruits aside from the oranges and celery amounted to $5.75, and furnished 1,909 grams of protein and 58,000 calories of energy, or, in round numbers, ten times as much as was obtained in the oranges and celery.

It must not be forgotten, however, that fruits are valuable for other reasons than the nutrients which they furnish. They contain acids and other bodies which are believed by physiologists to have a beneficial effect on the system and doubtless very often stimulate the appetite for other food. They are also useful in counteracting a tendency to constipation. Another point—and one entirely apart from food value—should not be overlooked. That is, fruits add very materially to the attractiveness of the diet. It is not easy to estimate their value from this standpoint, since often the appearance of food has a value which can not be measured in dollars and cents.—C. F. LANGWORTHY.

WHEN TO CUT ALFALFA.

It is generally believed that the state of growth has an effect on the food value of forage plants. When plants are young and growing rapidly they require an abundance of food material. This is formed by the plant from materials taken from the air and soil. The nutritive material to be of use to the plant must be in a soluble form, so that it can be carried in the sap from the place where it is formed or stored to the place where it is needed. The soluble material containing nitrogen has been found to be less valuable as a feeding stuff for animals than the insoluble nitrogenous compounds which are stored by the plant as reserve materials. It will be seen that if a forage crop is cut too early it might contain less of the valuable nitrogenous constituents than if cut later. The state of growth also has an effect on the other constituents. It is known that as plants mature the percentage of crude fiber in them increases. As this is comparatively indigestible, it is desirable to cut the crop before it is too ripe. While the facts may not be often considered, they are quite generally recognized in practice. Experience has taught the best time to cut forage crops to secure the best hay.

Several stations have studied the composition and value of alfalfa at different stages of growth. The Utah Station has devoted much time to determining the composition of different parts of the plant and of the whole plant of different crops and cuttings and their food value. Similar studies have been made by the Colorado Station and at the Ontario Experimental Farm. In a previous bulletin of this series[1] some of the results of these investigations have been noted.

[1] U. S. Dept. Agr., Farmers' Bul. 56 (Experiment Station Work—I).

The composition of alfalfa of the first, second, and third cuttings, as determined by the Colorado Station, is shown by the following table:

Composition of alfalfa.[1]

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
First cutting (early bud)	7.17	15.12	1.24	30.98	34.73	10.76
Second cutting (early flower)	7.49	17.08	1.66	36.17	26.28	11.32
Third cutting (late flower)	8.14	15.88	1.69	34.63	28.34	11.32

[1] Air-dried hay.

The composition of the different cuttings does not vary greatly; that is, during the period from the first cutting (early bud) to the third cutting (late flower) the proportion of the different nutrients in the plant is not changing very rapidly. If cut before this time the plant would doubtless be too immature; that is, there would be an excess of the constituents which are less valuable for food. The Utah investigations led to conclusions similar to those from the Colorado work. The principal deductions follow:

The total dry matter of the alfalfa crop increases up to the time the tops die down. The greatest gains in dry matter occur during the week between budding and medium bloom. Later the gains are insignificant. The total amount of nitrogen-free extract increases up to the time the tops die down, though the relative amount diminishes as the plants grow older. Both the total and relative amounts of crude fiber increase until the plants die down, the formation being most rapid during the flowering period. The total quantity of albuminoids increases up to the first week of full flowering and decreases after this time. The percentage of albuminoids is greatest in the young plants and decreases as the plants grow older. The nonalbuminoid nitrogenous compounds are rapidly converted into albuminoids at the time of budding. The feeding value of the alfalfa crop does not diminish from the period of budding to that of full flowering.

To obtain the largest yield of dry matter and albuminoids, alfalfa should be cut not earlier nor later than the first week of early flowering. This in most cases will be two or three weeks after the flower buds first appear. It would be a more serious error to cut too early than too late. The first, second, and third crops have about the same food value, pound for pound. When the alfalfa flowers begin to appear, the stalks constitute about 50 or 60 per cent and the leaves 40 or 50 per cent of the whole plant. At the usual time of cutting, alfalfa leaves contain one-third or more of the total dry matter of the crop. The leaves contain one-third to one-fourth as much crude fiber as the stalks and two or three times as much albuminoids.

The Utah Station made extended studies with steers of the digestibility of different crops and cuttings of alfalfa. The results are summarized in the following table:

Coefficients of digestibility of alfalfa hay by steers.

	Dry matter.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
First crop; average of first, second, and third cuttings	58.78	65.07	35.00	72.41	40.15	41.62
Second crop; average of first, second, and third cuttings	60.32	70.48	42.25	71.74	44.36	46.16
Third crop	58.17	69.30	41.51	71.00	34.30	44.25
Average of all	59.64	67.99	39.04	72.36	41.12	43.94
Mixed alfalfa, 1896	60.16	70.30	50.57	71.80	45.67	40.85

As indicated by the above table, the digestibility of alfalfa remained practically constant from the time of budding to the period of full bloom.

Investigations at the Colorado Station indicated that, while there were some chemical changes during storage there was no material loss in food value of alfalfa hay, properly stored, even after the lapse of a considerable length of time.

From all these experiments the general deductions can be drawn that alfalfa should be cut when the proportion of the most valuable food constituents is highest—that is, when the blooming period has commenced but the plant has not begun to die down. The hay changes somewhat when stored for a considerable length of time, but its chemical composition does not indicate that the food value is materially diminished.—C. F. LANGWORTHY.

SPONTANEOUS COMBUSTION OF HAY.

Fires which are reported to be caused by the spontaneous combustion of hay are by no means rare. While some of them are doubtless of an incendiary origin, others are really due to the cause assigned. Such a case was recently reported by the Pennsylvania Station. The fire was discovered in the haymow of the station barn. The mow was directly over the cow stable. Precautions were taken to exclude drafts and, as there was a sufficient supply of water available, the fire after a time was extinguished. The fire was confined to the central portion of the hay and a number of holes were burned through the ceiling of the cow stable. These were so situated that it apparently would have been impossible for the fire to have originated from any other cause than spontaneous combustion. A considerable part of the hay was thrown out of the mow. An examination showed that a large portion of it was so thoroughly charred that it would crumble. Some of the hay had not been subjected to so great heat and was only browned in color. However, it was unfit for stock feeding.

For several days previous to the fire a peculiar odor had been noticed about the barn and a somewhat careful examination was made to ascertain its source. The

result of this examination seemed to indicate that the rowen in this mow was heating, but no indication of fire was seen or even suspected. This odor was noticed not only by men working about the barn, but by other persons who had occasion to pass on the leeward side within forty or fifty rods of the barn. The odor was so strong that it was observed by many people and compared by some to that of burning grain. While positive proof as to the origin of this fire may be lacking, the circumstances are such that it seems safe to consider it of spontaneous origin.

It is well known that when moist hay is stored under favorable conditions fermentation takes place, which may produce a considerable amount of heat. According to recent investigations made in Germany, the amount of heat may be sufficient to set fire to the hay. Under suitable conditions some of the organic matter of the hay is oxidized by the oxygen of the air. Carbon dioxid and water are produced. The water moistens the hay and the moistened material ferments. Fermentation produces carbon dioxid, water, and small amounts of other compounds. Heat also is produced. The fermentation is more active if the material is moistened at the beginning. However, the water produced by the oxidation of the materials is sufficient to start it. This fermentation produces a temperature of about 132.8° F. At this temperature a second and more violent oxidation takes place and the temperature rises to about 194° F. Other processes then take place which char the material and cause a slow rise of temperature to 266° F. When this temperature is reached, the hay chars rapidly. All these processes destroy at least half of the material present. Theoretically, the temperature may rise to 374° F. According to the tests made, clover hay will become ignited at 302°–392° F.

Spontaneous combustion is indicated by the hay becoming darker in color until it is finally black, by a sooty odor, and by smoke irritating to the eyes. The ash of the burned hay has a characteristic grayish-white appearance and feels like sand. The burned hay is surrounded by a layer of charred but not burned material, which is a poor conductor of heat.—C. F. LANGWORTHY.

PRESERVATION OF MILK BY PRESSURE.

A preliminary report on experiments conducted to determine the effect of pressure in the preservation of milk is given in a recent bulletin of the West Virginia Experiment Station. The samples of milk used in the tests were inclosed in collapsible tin tubes and placed in hollow steel cylinders of various patterns and make. The space surrounding the tubes was filled with water. The cylinders were fitted with pistons, to which hydraulic pressure was applied. Several hundred samples of milk were subjected to pressures ranging from several hundred pounds to 100 tons per square inch and compared with samples receiving similar treatment except pressure.

It was found that at room temperatures milk subjected to pressures of 10 to 15 tons for as many days was sweet at the end of the tests.

The souring of the milk was not materially delayed by pressures much lower than this. Pressures of 30 tons for 1 hour delayed souring for upwards of 24 hours as compared with the check samples. Pressures of 70 to 95 tons for several minutes to 1 hour kept the milk sweet from 2 to 7 days. With the temperature of the milk raised to 140 to 170° F. pressures of 5 to 20 tons gave better results than corresponding pressures at the lower temperatures. In no case were the bacteria in the milk completely destroyed. A pressure of 10 to 15 tons for 8 days was found insufficient to kill germs of typhoid fever, tuberculosis, and other diseases which had been added to the milk. These germs were found more resistant to the treatment than those concerned in the souring of milk. In a number of cases in which souring had been prevented by pressure other changes were observed. The practical application of pressure in the shipment of milk is considered a possibility by the author of the bulletin, and work along this line is being continued.—H. W. LAWSON.

CREAM RAISING BY DILUTION.

A renewed interest in cream raising by dilution, especially in connection with various devices for creaming purposes put upon the market as "gravity or dilution separators," is indicated in recent publications of several experiment stations.

At the New York Cornell Station the subject of patents on these "separators" was investigated, and practical trials were made of several of them. The devices, or cans, as they may properly be called, are considered similar in essential features to well-known cans used in deep setting. They are provided usually with scale glasses and with a faucet near the bottom for drawing off the skim milk. Among the novel features of different cans, as claimed by the manufacturers, the following may be noted: A central cooler supported on legs over the outlet in the bottom of the can; a central tube with a perforated enlargement at the lower end, through which the water is added in diluting the milk; a curved or slanting bottom; and a strainer over the outlet.

In all of the cans the separation of cream depends upon gravity, and the designation of them as separators is pointed out as misleading, inasmuch as that term is by common usage applied to machines in which the cream is separated by centrifugal force. As a result of the inquiry concerning patents it is held that the patents granted on these cans cover unimportant details of construction, and that "anyone desiring to use this process of doubtful utility is perfectly free to do so without let or hindrance from the holder of any patent right whatever."

In the practical tests at the New York Cornell Station with mixed milk from a herd, in which many of the cows were nearly dry, dilution with water between 50 and 60° F., and setting at a temperature of 65

to 75°, gave results approximately the same as those obtained by deep setting in ice water with a Cooley can. With milk from cows comparatively fresh, cold deep setting gave considerably better results than the dilution method.

A two week's trial of a dilution "separator" was made at the Michigan Station. Forty pounds of milk were diluted one-half with water at 60° and allowed to stand for 24 hours. The average fat content of the skim milk was 0.7 per cent, calculated for undiluted skim milk. "Not only was the loss excessive, but the skim milk thus diluted with so much water could not be fed to advantage and the cream soured rapidly."

One hundred and twenty trials of the same "separator" were made at the Vermont Station. "The gravity separator left in the skim milk 13 per cent of the fat of the mixed milk, 40 per cent of the fat of the Ayrshire milk, and 17 per cent of the fat of the stripper milk. The centrifugal separator left between 1 and 2 per cent of the fat of these milks behind in the skim milk. The results speak for themselves and call for no further comment."

Recent work shows that the efficiency of cream raising by dilution is not increased by the use of these so-called separators; while earlier work of the stations indicates that, with the possible exception of milk from cows in advanced lactation or where deep setting in ice water can not be practiced, the process is not of practical benefit and that in addition to a waste of cream and other disadvantages it materially lessens the feeding value of the skim milk.—H. W. LAWSON.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FERTILIZERS.

Complete fertilizer is one which contains the three essential fertilizing constituents, i. e., nitrogen, phosphoric acid, and potash.

Nitrogen exists in fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrates. It is the most expensive fertilizing ingredient.

Nitrates furnish the most readily available forms of nitrogen. The most common are nitrate of soda and nitrate of potash (saltpeter).

Nitrification is the process by which the highly available nitrates are formed from the less active nitrogen of organic matter, ammonia, salt, etc. It is due to the action of minute microscopic organisms.

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Superphosphate.—In natural or untreated phosphates the phosphoric acid is insoluble in water and not readily available to plants. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available to plants. Superphosphates are sometimes called acid phosphates.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water and are believed to be nearly, if not quite, equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvinit, muriate of potash, sulphate of potash, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Albuminoid nitrogen is nitrogen in the form of **albuminoids**, which is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of albuminoids.

Amid nitrogen is nitrogen in the form of **amids**, one of the groups of substances classed together under the general term protein. Amids, unlike albuminoids, are usually soluble in water, but are generally considered of less value as food than albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are often classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned, to furnish heat and energy.

MISCELLANEOUS TERMS.

Humus is the name applied to the partially decomposed organic (animal and vegetable) matter of the soil. It is the principal source of nitrogen in the soil.

Micro-organism, or microscopic organism, is a plant or animal too small to be seen without the aid of a compound microscope.

Fungus (plural, **Fungi**) is a low form of plant life destitute of green coloring matter; molds and mushrooms are familiar examples. Many diseases of plants are due to fungi.

Bacterium (plural, **Bacteria**) is the name applied in common to a number of different or closely related microscopic organisms, all of which consist of single short cylindrical or elliptical cells or two such cells joined end to end and capable of spontaneous movement. Many kinds of bacteria are harmful and cause diseases and other injurious effects, but many are beneficial. Among the latter are those which give flavor to butter and cheese, and those which enable leguminous plants to use the free nitrogen of the air.

Pollen.—The powdery substance, usually yellow or brown, which falls from flowers when they are shaken.

Pollination is the act of conveying pollen to the part of the flower prepared to receive it. Pollination may be brought about either by natural agencies, such as wind, insects, etc., or by artificial means.

Self-fertile plants or varieties are those which do not require pollen from other plants or varieties in order to produce seeds or fruit.

Self-sterile plants or varieties are those which do require pollen from other plants.

Lactation.—The formation or secretion of milk. The "period of lactation" as applied to cows means the length of time since calving that they have been giving milk.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24. No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20. No. 21. Barnyard Manure. Pp. 32. No. 22. Feeding Farm Animals. Pp. 32. No. 23. Foods: Nutritive Value and Cost. Pp. 32. No. 24. Hog Cholera and Swine Plague. Pp. 16. No. 25. Peanuts: Culture and Uses. Pp. 24. No. 26. Sweet Potatoes: Culture and Uses. Pp. 30. No. 27. Flax for Seed and Fiber. Pp. 16. No. 28. Weeds; and How to Kill Them. Pp. 30. No. 29. Souring of Milk, and Other Changes in Milk Products. Pp. 23. No. 30. Grape Diseases on the Pacific Coast. Pp. 16. No. 31. Alfalfa, or Lucern. Pp. 23. No. 32. Silos and Silage. Pp. 31. No. 33. Peach Growing for Market. Pp. 24. No. 34. Meats: Composition and Cooking. Pp. 29. No. 35. Potato Culture. Pp. 23. No. 36. Cotton Seed and Its Products. Pp. 16. No. 37. Kafir Corn: Characteristics, Culture, and Uses. Pp. 12. No. 38. Spraying for Fruit Diseases. Pp. 12. No. 39. Onion Culture. Pp. 31. No. 40. Farm Drainage. Pp. 24. No. 41. Fowls: Care and Feeding. Pp. 24. No. 42. Facts About Milk. Pp. 29. No. 43. Sewage Disposal on the Farm. Pp. 22. No. 44. Commercial Fertilizers. Pp. 24. No. 45. Some Insects Injurious to Stored Grain. Pp. 32. No. 46. Irrigation in Humid Climates. Pp. 27. No. 47. Insects Affecting the Cotton Plant. Pp. 32. No. 48. The Manuring of Cotton. Pp. 16. No. 49. Sheep Feeding. Pp. 24. No. 50. Sorghum as a Forage Crop. Pp. 24. No. 51. Standard Varieties of Chickens. Pp. 48. No. 52. The Sugar Beet. Pp. 48. No. 53. How to Grow Mushrooms. Pp. 20. No. 54. Some Common Birds in Their Relation to Agriculture. Pp. 40. No. 55. The Dairy Herd: Its Formation and Management. Pp. 24. No. 56. Experiment Station Work—I. Pp. 30. No. 57. Butter Making on the Farm. Pp. 15. No. 58. The Soy Bean as a Forage Crop. Pp. 24. No. 59. Bee Keeping. Pp. 32. No. 60. Methods of Curing Tobacco. Pp. 16. No. 61. Asparagus Culture. Pp. 40. No. 62. Marketing Farm Produce. Pp. 28. No. 63. Care of Milk on the Farm. Pp. 40. No. 64. Ducks and Geese. Pp. 48. No. 65. Experiment Station Work—II. Pp. 32. No. 66. Meadows and Pastures. Pp. 24. No. 67. Forestry for Farmers. Pp. 48. No. 68. The Black Rot of the Cabbage. Pp. 22. No. 69. Experiment Station Work—III. Pp. 32. No. 70. The Principal Insect Enemies of the Grape. Pp. 24. No. 71. Some Essentials of Beef Production. Pp. 24. No. 72. Cattle Ranges of the Southwest. Pp. 32. No. 73. Experiment Station Work—IV. Pp. 32. No. 74. Milk as Food. Pp. 39. No. 75. The Grain Smuts. Pp. 20. No. 76. Tomato Growing. Pp. 30. No. 77. The Liming of Soils. Pp. 19. No. 78. Experiment Station Work—V. Pp. 32. No. 79. Experiment Station Work—VI. Pp. 28. No. 80. The Peach Twig-borer—An Important Enemy of Stone Fruits. Pp. 16. No. 81. Corn Culture in the South. Pp. 24. No. 82. The Culture of Tobacco. Pp. 23. No. 83. Tobacco Soils. Pp. 23. No. 84. Experiment Station Work—VII. Pp. 32. No. 85. Fish as Food. Pp. 30. No. 86. Thirty Poisonous Plants. Pp. 32. No. 87. Experiment Station Work—VIII. Pp. 32. No. 88. Alkali Lands. Pp. 32. No. 89. Cowpeas. Pp. 16. No. 90. The Manufacture of Sorghum Sirup. Pp. 32. No. 91. Potato Diseases and Their Treatment. Pp. 12. No. 92. Experiment Station Work—IX. Pp. 30. No. 93. Sugar as Food. Pp. 27. No. 94. The Vegetable Garden. Pp. 24. No. 95. Good Roads for Farmers. Pp. 47. No. 96. Raising Sheep for Mutton. Pp. 48. No. 97. Experiment Station Work—X. Pp. 32. No. 98. Suggestions to Southern Farmers. Pp. 48. No. 99. Common Insects on Shade Trees. Pp. 30. No. 100. Hog Raising in the South. Pp. 40. No. 101. Millets. Pp. 28. No. 102. Southern Forage Plants. Pp. 48. No. 103. Experiment Station Work—XI. Pp. 32. No. 104. Notes on Frost. Pp. 24.